TITLE: VIBRATING SCREEN WITH A LOADING PAN

FIELD OF THE INVENTION

This invention pertains to vibrating screens for screening gravel, top soil, and the like, and more particularly, it pertains to a vibrating screen having a loading pan thereon for receiving loads of screenable material from a bucket loader and for controlling the flow of these loads to the screen box.

BACKGROUND OF THE INVENTION

Small and portable vibrating screens are used for examples, by landscape contractors, gardeners, farmers, and excavation and trucking companies. These vibrating screens are usually loaded by small Skid-Steer $_{TM}$ loaders or other similar front-end bucket loaders. This type of small portable vibrating screens is illustrated and described in Applicant's **US Patent 5,899,340** issued on May 4, 1999.

When a load of gravel is dropped all at once in the upper end of a common vibrating screen, the upper springs become compressed, thereby collapsing the upper half of the screen box for a few seconds. During that period, the amplitude of the vibration of the screen box is reduced at the top and increased at the bottom. The screening action is correspondingly reduced at the top. The efficiency of the vibrating screen remains low until the upper springs can recover their operating shapes. This collapsing of a vibrating screen under sudden loads is typical of all common machines having coil springs set vertically under the screen box. Most small portable vibrating screens of the prior art have this type of spring arrangement and suffer from the same drawback.

Therefore, it is believed that there is a market need for a small portable vibrating screen which can maintain a better efficiency when a load of screenable material is dropped in the upper end of the screen box.

A first attempt to reduce the collapsing of the upper end of a vibrating screen has been disclosed in the **US Patent 5,082,555**, issued to James L. Read on January 21, 1992. In this invention, the vibrating screen has a tilting hopper laid over and covering the screen box. The screenable material is dropped into this hopper by a front-end loader. The hopper is pivoted on the upper end of the machine's frame, and is raised and lowered by hydraulic cylinders. The hopper has a discharge end which coincides with the top end of the screen box. Once loaded, the hopper is tilted at a desired speed to control the flow of screenable material to the screen box.

Although this hopper feeding system has undeniable merits, it has several moving parts and is controlled by an electric timer and a photoelectric switch. These control devices and moving parts are subject to deterioration from dust and shocks associated with the environment in which a vibrating screen operates. Therefore, it is believed that there continues to be a need for a sturdy and maintenance free loading arrangement to control the flow of material in a vibrating screen.

SUMMARY OF THE INVENTION

In the vibrating screen according to the present invention, there is provided a static combination of elements which contribute cooperatively and individually to control the flow of screenable material to the screen box.

In a first aspect of the present invention, there is provided a vibrating screen for separating fine materials from coarse materials. The vibrating screen comprises a frame having a vertical tall end, a vertical short end and a screen box having an upper end, a lower end, a top screen therein and an inclination from the horizontal plane. A first pair of springs are affixed to the tall end of the frame for supporting the upper end of the screen box over the tall end of the frame, and a second pair of springs are affixed to the short end of the frame and to the lower end of the screen box for supporting the lower end of the screen box over the short end of the frame. The vibrating screen also has an eccentric shaft affixed to the screen box and a drive means affixed to the frame and to the eccentric shaft for rotating the eccentric shaft and for imparting a reciprocal movement to the screen box.

The vibrating screen according to this first aspect of the present invention is characterized by a loading pan affixed to the upper end of the screen box, and rigid structural members extending under the screen box and the loading pan for maintaining the loading pan in a same plane as the screen box. The loading pan is set substantially over the upper springs such that a flexion of the structural members in use under the loading pan is minimum.

In accordance with another aspect of the present invention, the loading pan is wider than the screen box. More specifically, the loading pan is about 60% wider than the screen box. The loading pan has a plated bottom surface and sloped sides forming a funnel on the upper end of the screen box. In use, the sloped sides retain about 30% or more of a load of screenable material in the loading pan until most of the central portion of the load has been moved over to the top screen. The flow of screenable material from the loading pan to the top screen is thereby more uniform.

In yet another aspect of the present invention, each of the first and second pairs of springs have torsion bushings therein, and a pair of arms joining the torsion bushings and forming an acute angle pointing toward the lower end of the screen box. The top arm in each spring makes an angle with the horizontal plane, which is greater than the inclination of the screen box. Because of this characteristic, the friction forces caused by a load of screenable material in the loading pan produce a torque on each spring in a direction opposite a vertical loading on each spring, to reduce a collapsing of the springs in use.

Still another feature of the vibrating screen of the present invention is that it is susceptible of a low cost of manufacture with regard to both materials and labour, and which accordingly is then susceptible of low prices of sale to the consumer, thereby making such vibrating screen economically available to the public.

Other advantages and novel features of the present invention will become apparent from the following detailed description of the preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

One embodiment of the present invention is illustrated in the accompanying drawings, in which like numerals denote like parts throughout the several views, and in which:

FIG. 1 is a perspective side, top and front view of the vibrating screen according to the preferred embodiment of the present invention;

FIG. 2 is a partial side view of the vibrating screen;

FIG. 3 is a top view of the screen box;

FIG. 4 is a cross-section view of the loading pan as seen along line **4-4** in **FIG. 3**;

FIG. 5 is another partial side view of the vibrating screen with the screen box shown in a cut-away view to show a load of screenable material therein;

FIG. 6 is a diagram representing the flexion of the structural members under the screen box in use;

FIG. 7 is another side view of the vibrating screen showing one of the springs supporting the screen box;

FIG. 8 is another perspective side, top and front view of the vibrating screen according to the preferred embodiment of the present invention, showing various optional features therefor;

FIG. 9 is a cross-section view of the screen box taken across the longitudinal axis of the screen box, substantially along **line 9-9** in **FIG. 3**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

While this invention is susceptible of embodiment in many different forms, there is shown in the drawings and will be described in details herein one specific embodiment, with the understanding that the present disclosure is to be considered as an example of the principles of the invention and is not intended to limit the invention to the embodiment illustrated and described.

Referring to **FIGS. 1** and **2**, the vibrating screen **20** according to the preferred embodiment is described herein below in a general form. The preferred vibrating screen **20** has an arched frame **22** supporting a screen box **24** on four springs **26** affixed to the top of the frame **22**. An engine **28** drives an eccentric shaft **30** affixed to the screen box **24**, to impart a vibrating movement to the screen box **24**.

The preferred springs **26** are of the type known as oscillating mountings, manufactured by ROSTA-WERK AG, a company from Switzerland having distributors throughout the world. Each spring **26** is characterized by two pairs of torsion bushings each comprising a square stub embedded in a rubber-packed housing. A torsion bushing in each pair share a common housing. The torsion bushings are perpendicularly affixed to two arms making an acute angle having a closed end near the common housing. These springs are known in the industry as $\mathrm{ROSTA}_{\mathrm{TM}}$ springs.

The frame **22** of the vibrating screen has a short end and a tall end. Both ends comprise ballast **32** between the vertical frame members to stabilize the vibrating screen in use. The short end ballast has a socket **34** there through to receive a tow hitch **36**, and the tall end has brackets **38** thereon

to receive an axle and wheel set **40** for transporting the vibrating screen between job sites.

A panel **42** extends along one side of the frame **22** to form with both ends of the frame an enclosure under the vibrating screen to retain a pile of fines under the vibrating screen.

The screen box **24** has a discharge chute **44** on its lower end extending to one side of the frame next to the panel **42**, to accumulate the rejects of the top screen **46** at that location. Although only the top screen **46** is visible in the drawings, a second screen may be provided under the top screen to produce a third grade of screened material. The discharge end of the second screen is next to the short end of the vibrating screen, under the chute **44**. A second screen will be described later and is illustrated in **FIG. 9**.

The frame **22** of the vibrating screen, the engine **28** , the eccentric shaft **30**, the towing accessories **34**, **36**, **38** and **40**, and the chute **44** are not described further herein for not being the focus of the present invention.

Referring now to **FIGS. 3** and **4**, one of the features of the vibrating screen **20** will be described. The screen box **24** is made of metal plates and metal structural members enclosing the top screen **46.** The screen box **24** has a loading pan **50** on its upper end, above the upper edge **52** of the top screen **46**. The loading pan **50** is also made of metal plates and metal structural members. The preferred width **'A'** of the loading pan is at least about 1.5 times, and preferably 1.6 times or more, the width **'B'** of the top screen. A 48 inch-wide screen for example has a preferred loading pan width **'A'** of about 78 inches. This dimension has been found advantageous for loading

the vibrating screen with a Skid-Steer $_{TM}$ loader or a similar small bucket loader.

The preferred length of the loading pan **'C'** is about 24 inches, such that the loading pan **50** can receive the entire load of a small bucket loader. The loading pan **50** has a central plated surface **52** defined by inclined side surfaces **54**. The loading pan **50** also has inclined sloped surfaces **56** defining a funnel between the inclined side surfaces **54** and the sides **58** of the screen box **24**. Each sloped surface **56** forms an angle **'D'** between 120^0 and 150^0, and preferably about 135^0 with a respective inclined side surface **54**, or with a respective side **58** of the screen box. The depth **'E'** of the loading pan **50** is about the same as the depth of the screen box **24**.

The central region **60** of the loading pan **50** preferably lies upon the axis **62** of the upper springs **26**, although there are also advantageous results to be obtained with the central region **60** of the loading pan **50** lying on the screen side of this axis, within the span **'F'** between the axis **62** of the upper springs and the axis **64** of the lower springs. These advantageous results will be explained later when making reference to **FIG. 6**, in particular.

It is to be noted that the shape of the loading pan **50** causes a load of screenable material to be partially and temporarily retained inside the loading pan, and to be released therefrom in a controlled manner. The projections **'G'** of the sloped surfaces **56** across the loading pan **50** constitute at least one third, and more precisely, about 38% of the total width of the loading pan. Therefore, a similar proportion of a load of screenable material dumped into the loading pan is temporarily retained against these sloped surfaces **56** until a central portion of the load has been

moved over to the top screen **46**.

It will be appreciated that a load of screenable material inside the loading pan is also partially and temporarily retained therein by friction forces against the bottom surface **52** of the loading pan **50**. It has been found that the shape of the loading pan causes a load of screenable material to flow in sequence from the top to the bottom of the central portion and then from the centre to the sides thereof, with the side portions flowing last. It has been found that this flow sequence helps to control the amount of screenable material moving to the top screen **46**, and contributes to maintaining the efficiency of the vibrating screen from the start to the end of each load.

The centring of the load upon the axis **62** of the upper springs also contributes to improving the flow of material over the screen surface. As can be appreciated from the illustrations in **FIGS. 5** and **6**, the screen box **24** and the loading pan **50** are on a same pair of structural members **70**, with the loading pan **50** centred on the axis **62** of the upper springs **26**, as mentioned before. In use, the structural members **70** flex up and down in reaction to the rotation of the eccentric shaft **30**, as illustrated in **FIG. 6**.

It will be appreciated that the amplitude **72** of the vibration shown in an exaggerated manner in **FIG. 6** is maximum at a mid-span of the structural members and is minimum at the springs **26**. This flexion amplitude added to the displacements **74** of the springs causes the vibration of the screen box to be maximum at the mid-span of the screen box and minimum at the upper and lower axes **62**, **64**. This minimum vibration at the central region **60** of the loading pan **50** also contributes to improving the uniformity of a flow of screenable material from the loading pan to the screen box.

It will also be appreciated that the position of the loading pan in-line with the axis of the upper springs or within the span **'F'** of the springs contributes to reducing any cantilevered loading on the structural members **70**. It is known that such cantilevered loading would occur if the loading pan would be centred well above the upper springs. It is also known that such cantilevered loading can cause a deflection in the structure of a screen box which is out-of-phase with the rotation of the eccentric shaft, and damage the vibrating screen.

Another feature of the present invention will be described while making reference to **FIG. 7** in particular. The structural members **70** under the screen box **24** and the loading pan **50** are preferably set at an inclination **'H'** of about 18^0 from the horizontal plane for screening loam, peat moss and the like, and at 22^0 for screening sand and gravel.

As mentioned herein before, each spring **26** has two arms **80, 82** joining two pairs of torsion bushings. The lower mounting housing **84** is affixed to the frame **22** of the vibrating screen, and the upper housing **86** is affixed to the screen box **24**. The other two torsion bushings are mounted in the common housing **88**.

The springs **26** are selected to maintain in use, and angle **'J'** of about 45^0 to 90^0 between the arms **80, 82** with the closed end of this acute angle near the common housing **88**. The mounting surfaces of the housings **84, 86** are set horizontally, and the closed end of the acute angle **'J'** is pointing toward the lower end of the screen box **24**.

For the purpose of understanding the following discussion, it should be noted that the upper arm **82** in each spring **26** is always inclined from the

horizontal plane, at an angle larger than the inclination **'H'** of the screen box **24**.

The weight **'W'** of a load of screenable material **76** generates a cosine force **90** perpendicular to the surface **52** of the loading pan **50**, and a sine force **92** tangent to, or in-line with the structural members **70** under the screen box **24**. The sine force **92** between a load of screenable material and the surface **52** of the loading pan **50** is composed of surface friction forces as illustrated by arrows **94** in **FIG. 3**, and holding forces applied by the sloped surfaces **56**, as illustrated by arrows **96**. A complete analysis of the magnitude of these forces is not necessary to understand the principle of the present invention. Generally, the sum of these forces **94**, **96** is always related the total weight of a load **76** in a proportion corresponding to the sine **92** of the inclination **'H'** of the screen box.

With a screen box inclined at an angle **'H'** of between 18^0 to 22^0, the friction forces **94**, **96**, and consequently the sine force **92** at each spring **26** corresponds to the sine of that angle times the weight of the load **'W'**. In other words, the sine force **92** on each spring **26** corresponds to between 30% to 37% of the total load **'W'** supported by that spring.

Because each spring **26** is mounted with the angle **'J'** of the arms **80, 82** pointing toward the short end of the screen box, and the top arm **82** is angled downward from the structural members **70**, the sine force **92** translated to the upper housing **86** applies a torque **100** on the spring **26** in a direction causing the spring to extend. This torque **100** is opposite from the torque **102** caused by the cosine component **90** of the load **'W'**. While the cosine component **90** of a load tends to collapse the spring **26**, the sine component **92** tends to extend the spring. For this reason, the total

deflection of each spring **26** is not as much as in same size vibrating screen having coil springs for example. The initial collapsing of the upper springs when a load is dumped all at once in the screen box is thereby not as severe as compared to vibrating screens of the prior art.

Referring now to **FIGS. 8** and **9**, there are illustrated therein four optional features that are advantageous to accommodate different situations.

Firstly, a small, short-arm loader with a shallow bucket may have difficulty reaching under the vibrating screen **20** to handle all the fine material therefrom. In these situations, the panel **42** is preferably mounted inside the frame **22** directly under the top screen **46**. In this arrangement, a deflector **120** joins the top edge of the panel **42** to the side framing member **122**, to deflect the fines to the far side of the vibrating screen **20** relative to the view illustrated in **FIG. 8**.

In a second option, the rear edge of the loading pan is preferably enclosed by a plate **124** as illustrated in **FIG. 8**, when working with non-adhering material in a vibrating screen that is set at the lower preferred inclination. The plate **124** prevents runout of screenable material toward the rear end of the machine. The plate **124** also facilitates the loading of the loading pan using a small bucket loader having limited horizontal reach with the arms in a raised position.

When production is more important than material retention inside the loading pan, the bottom surface of the loading pan, as shown by dotted line **126** in **FIG. 8**, is preferably inclined more than of the top screen **46** by an angle of about 4^0-5^0. This slope promotes a faster delivery of material to the top screen **46**.

Lastly, the screening of moist and sticking materials can represent a challenge to manufacturers of vibrating screens. A good solution to this problem has been obtained by providing a crown of about 1" over 48" across both the top screen **46** and the bottom screen **130** as illustrated in **FIG. 9**. It has been found that these curvatures promote an even distribution of materials over the screen surfaces.

In the screen of the present invention, the top screen **46** is supported by transversely curved flat bars **132**. The bottom screen **130** is supported by a rectangular insert **134** having longitudinal flat bars **136, 138** of different widths, mounted on their edges. The rectangular insert **134** is preferably fastened to the structural members **70** of the screen box by bolts **140**, such that it is easily removable for replacement with a flat screen when necessary.

As to other manner of usage and operation of the present invention, the same should be apparent from the above description and accompanying drawings, and accordingly further discussion relative to the manner of usage and operation of the vibrating screen would be considered repetitious and is not provided.

While one embodiment of the present invention has been illustrated and described herein above, it will be appreciated by those skilled in the art that various modifications, alternate constructions and equivalents may be employed without departing from the true spirit and scope of the invention. Therefore, the above description and the illustrations should not be construed as limiting the scope of the invention which is defined by the appended claims.